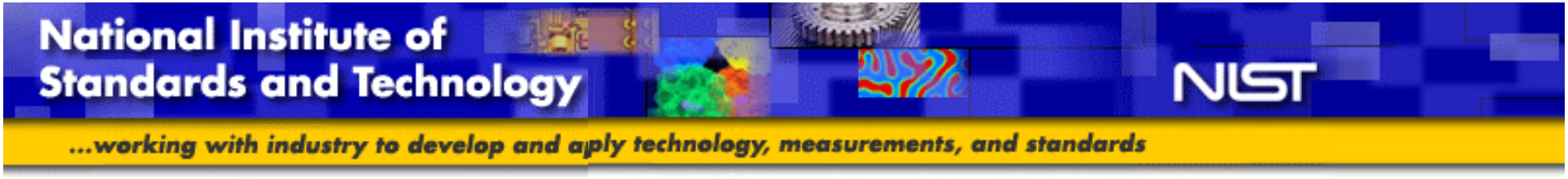


The Man Machine Interface

(Providing Critical Information, Anytime, Anywhere)

Walter W. Jones

Richard W. Bukowski

National Institute of Standards and Technology

May 13, 2001

Background

Fire alarm systems in large buildings incorporate a display for the fire service:

Location of alarms, device type, sequence

"… to enable responding personnel to identify the location of a fire quickly and accurately and to indicate the status of emergency equipment or fire safety functions that might affect the safety of occupants …"

Located in fire command center or near likely point of entry by the responding fire service.

The Concerns of the Fire Service

Improve Information Transfer: When, Where and How

Questions we asked at focus groups:

What do you want to know?

When do you want to know it?

Where do you want to know it?

How should it be presented?

Fire Service Needs

- **At Dispatch**
  - Confidence in alarm, size and growth rate of the fire
- **On Arrival**
  - Location of the fire, the occupants, current conditions
  - How to get to the fire
  - Staging areas, standpipes, other resource or safety issues
- **During the Incident**
  - Fire spread and growth, area(s) involved
  - Systems status, i.e., ventilation
  - Location of fire fighters
  - Controls for communications and ventilation

Incident Management

- **Initial systems report**
  - Systems active and operating
  - Areas occupied
- **Incident management information**
  - Current and “look ahead” conditions
- **Intuitive interface**
  - High Resolution – building management, firehouse, …
  - Panel – building panels, laptop/truck
  - Handheld – walkaround with Palm VII

Industry Perspective

- **Develop Prototype Graphics for Panels**
  Fire service doesn't use current panels
- **Develop a Model of Sensors**
  Current Detectors, then ...
- **Do Large Scale Verification**
  Conduct a Field Demonstration
- **Consortium**
  Siemens/Cerberus, Tyco/Simplex, GE/Honeywell/Notifier, SPX/EST, NEMA, NIST

NIST Perspective

- **Reliability of the signal (is it a fire?)**
  - Multimode sensors
  - Dispersed sensors
- **How big is the fire (if it is, how soon …)**
  - Flashover, backdraft, limits of protective clothing
- **Panel display – "information wherever it is needed"**
  - NFPA 72 Task Group
- **Tactical decision aid**
  - Impact of ventilation, what happens?

Premise!

- **Transducers will become common over the next decade**
  - Micro-electronic sensors
  - Demand for sensor rich buildings
- **Improvements in understanding can be made in utilizing the tremendous amount of data that will be available**

A Synergy Among Fire Alarm Systems and Other Fire Safety Systems

1) Surveillance

Monitor ALL fire safety systems to assure that they will operate as designed, when needed

2) Notification

Surveillance information reduces the need for inspections

Traditional role of notifying occupants and responders

3) Incident Management

Key information to enhance safety and efficiency of fire department operations

Major Tasks

- Extract alarm signals from current sensing technology, based on specified criteria. Use filtering at the panel rather than at the detector to identify patterns.
- Extract growth curve from T, OD, and other types of sensors.
- Develop a panel display and define the appropriate level of interaction based on the resolution of display and intended purpose.
- Develop an adaptive model which will start based on estimate of HRR and change based on extracting ät from comparison of $T_p(t)$, $T_e(t)$.
- Define a figure of merit for one or more detectors, the number of compartments to be protected and information available on building properties and current conditions.
- Full scale building demonstration of real time data delivery.

Detection and Alarm Project

- Low level sensing (early warning)
- High level sensing (fire following)
- Extract threat – heat, smoke, CO …
- Confirmation through
  - Multiple sensors
  - Feature extraction and modeling
- Display
  - High resolution, Laptop, wireless, beeper

Transducer Algorithm

Algorithm to measure the real environment seen by sensors

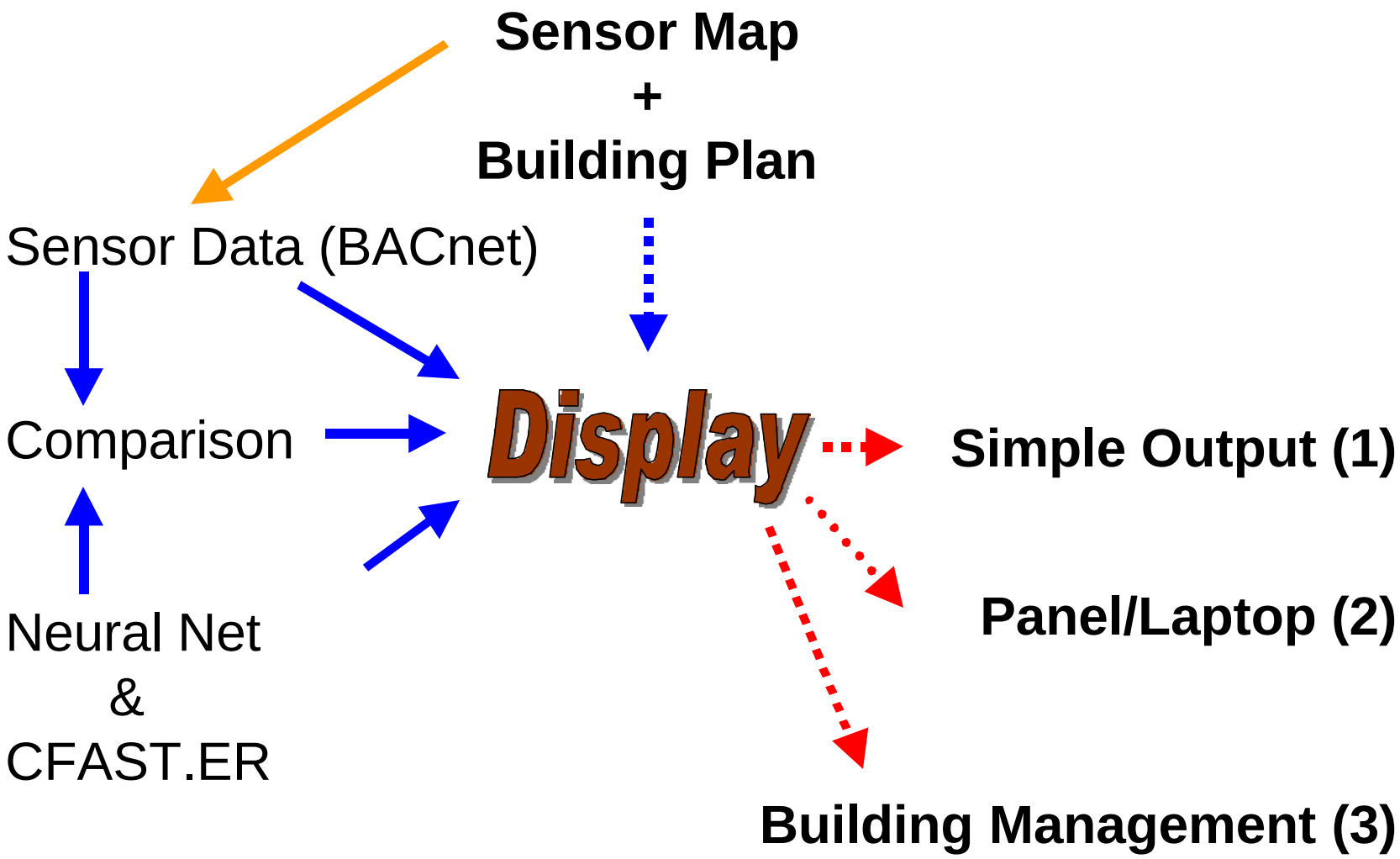
Real Time Model

Real time adaptive model with “on the fly” verification and HRR extraction

Links for Displays

Enroute

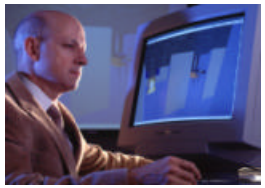
To Dispatch


Sensor Map
+
Building Plan
Sensor Data (BACnet)
Comparison
Neural Net
&
CFAST.ER
Display
Simple Output (1)
Panel/Laptop (2)
Building Management (3)

Delivery of Information – Examples

Layer

- **Building Management**
  Building security, fire station, …



3

- **Panel/Laptop**
  Laptop “in vehicles”
  Building annunciator panel

2

- **Simple Display**
  Handheld device

1

NFPA 72 Task Group – This Year

Working groups

- Icons (Usability, Color, Scaling)
- Control functions
- Information and presentation

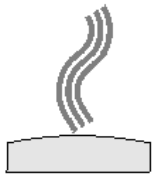
Proposal closing date was November, 2000

- For code cycle 2002
- Proposed first as an appendix to NFPA 72

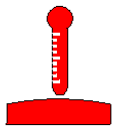
Scalable, Stylus, Icons, Inclusive, Intuitive

Illustrative Icons

- Drawn from Japanese standard and NFPA 170 symbols



- **Must represent three states**
  - Function not present
  - Function present and not active
  - Function present and active



- **Full Set at**
  - http://panel.nist.gov/

Prototype Icons

Alarm		Stairwell (all ratings)		Occupant	
Emergency Connection		Fire Department Key Box		Sprinkler	
Exhaust Fan		Fire Pump		Smoke Vent	
Exhaust Outlet		Fire Department Connection		Shutoff (W, E, G)	
Siamese Connection		Extinguishing System (i.e.CO_2 and Halon)		Water Mist Sprinkler	
High Pressure Gas		Egress in Progress		Electrical Room	
Manual Pull Station		Emergency Phone		Fire Service Access Point	
Smoke Detector		Fire		Elevator Equipment Room	
Standpipe		Gas Detector		Heat Detector	

27 proposed at the moment - Usability issues remain

Two Other Tasks

- **Control Functions**
  - Emergency voice communications - Zone, group, all call
  - Query sensors (incl. those not in alarm)
  - Manual ventilation control (stairways)
  - Elevators? (status of recall only?)

- **Presentation and Information**
  - Somewhat intuitive (some training)
  - Consistent
  - Available in building, outside, in vehicles, handheld, …
  - Familiar
  - Caution about color blindness

Information Possibilities

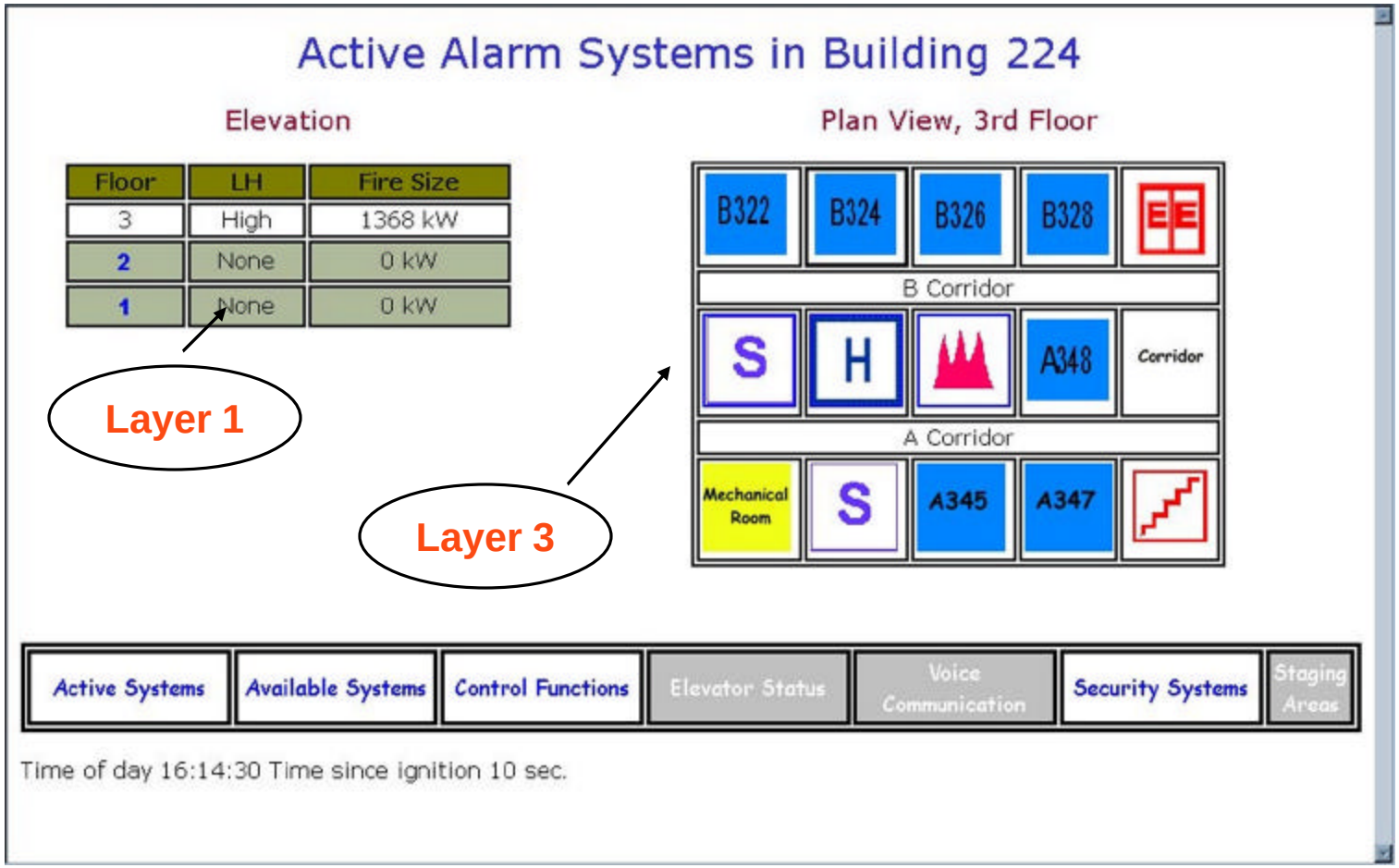
- **Location of occupants (from energy mgmt sys)**
- **Location and condition of firefighters**
- **Performance of fire protection systems (within design parameters, low/high, failed)**

NFPA 72 Task Group – Next Year

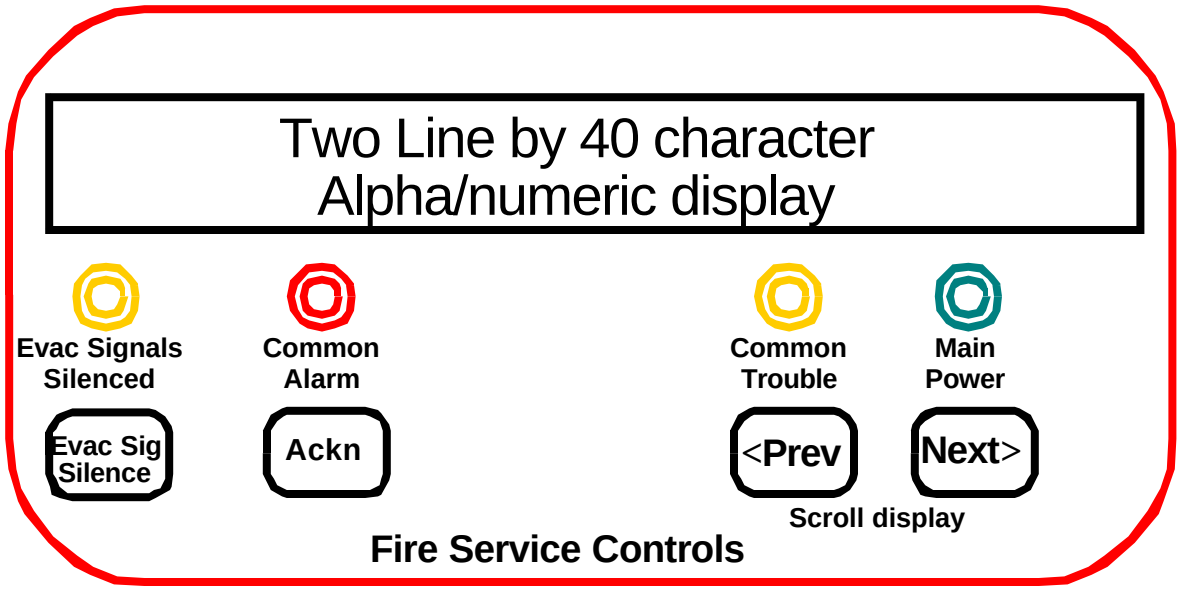
- **Work the NFPA 72 process through ROP, ROC, TCC, and Standards Council**

- **Demonstrations of example implementations**
  - Delaware (with CFSI) (wireless interface)
  - NIST
  - Commercial building

Implementation of Layers One and Three



Layer Two – The Control Interface



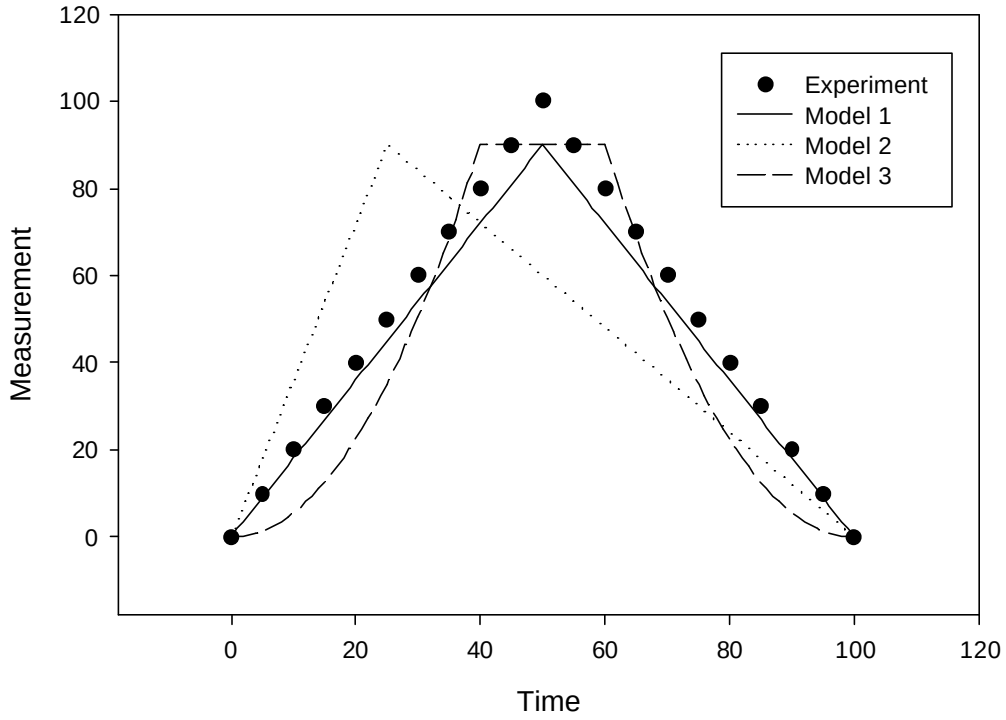
Reliability of the Signal

- **Method to compare curves**

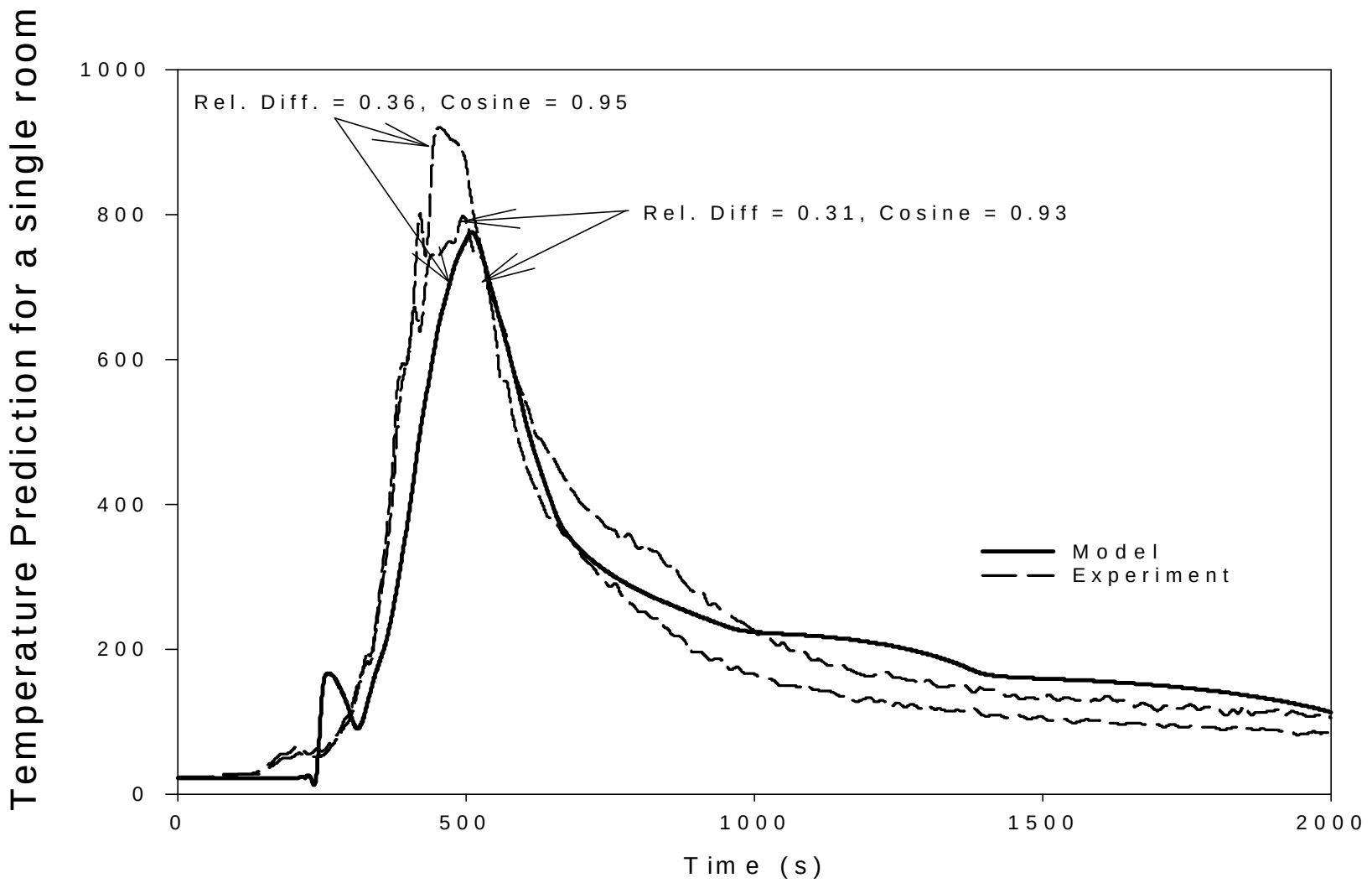
  Shape matching

- **Metric for the difference**

  Standard deviation of numerical models


120
100
80
60
40
20
0
Measurement
0
20
40
60
80
100
120
Time
Experiment
Model 1
Model 2
Model 3

One of our real room comparisons



Transducer Data in Real Time

- **Develop an algorithm of the operation of present day transducers**
- **Establish a protocol to test**

  This is the Detector Emulator..
- **Incorporate these signals**

Model of a Transducer

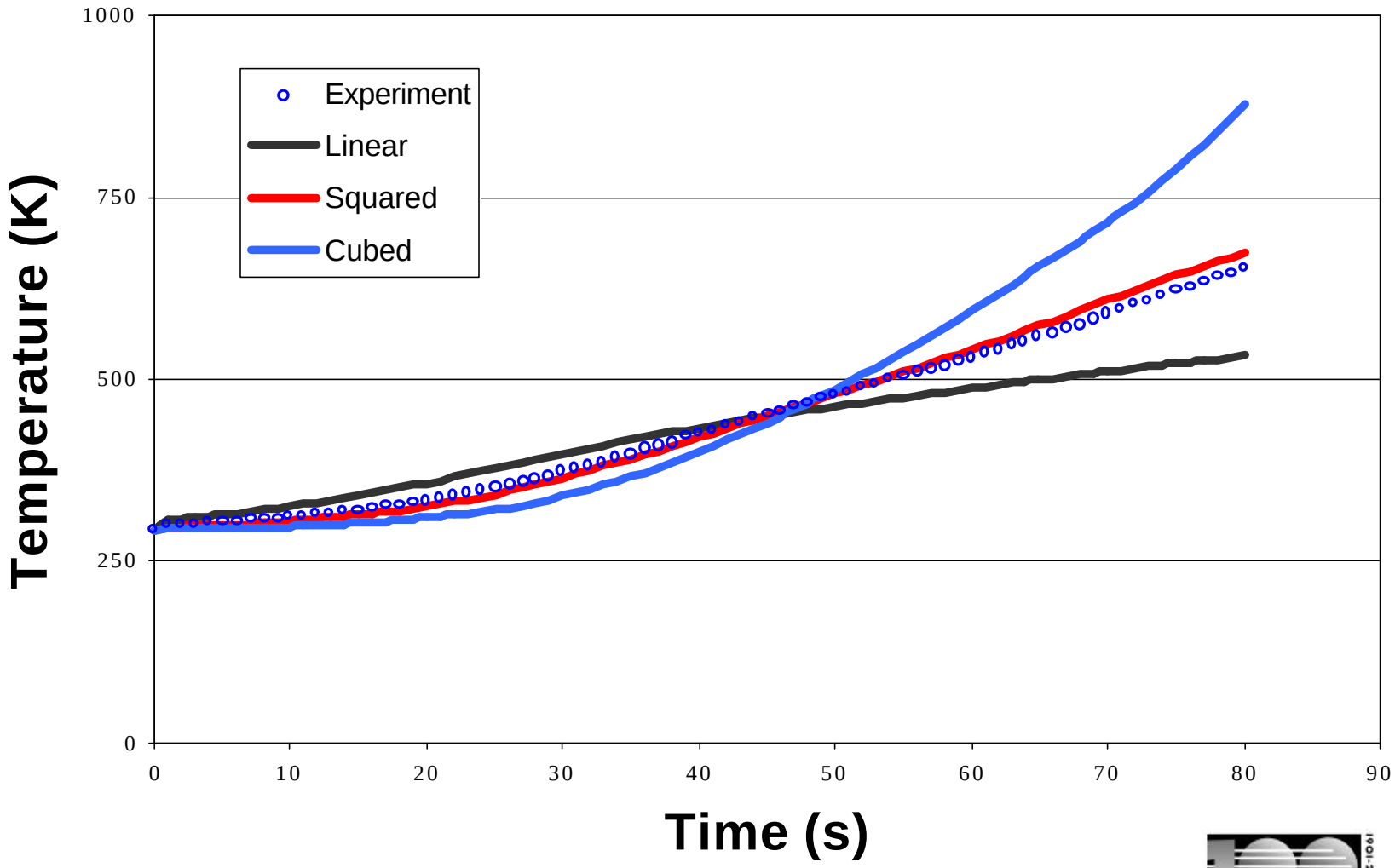
To interpret the signals from a sensor, one needs to understand the reason

Example:

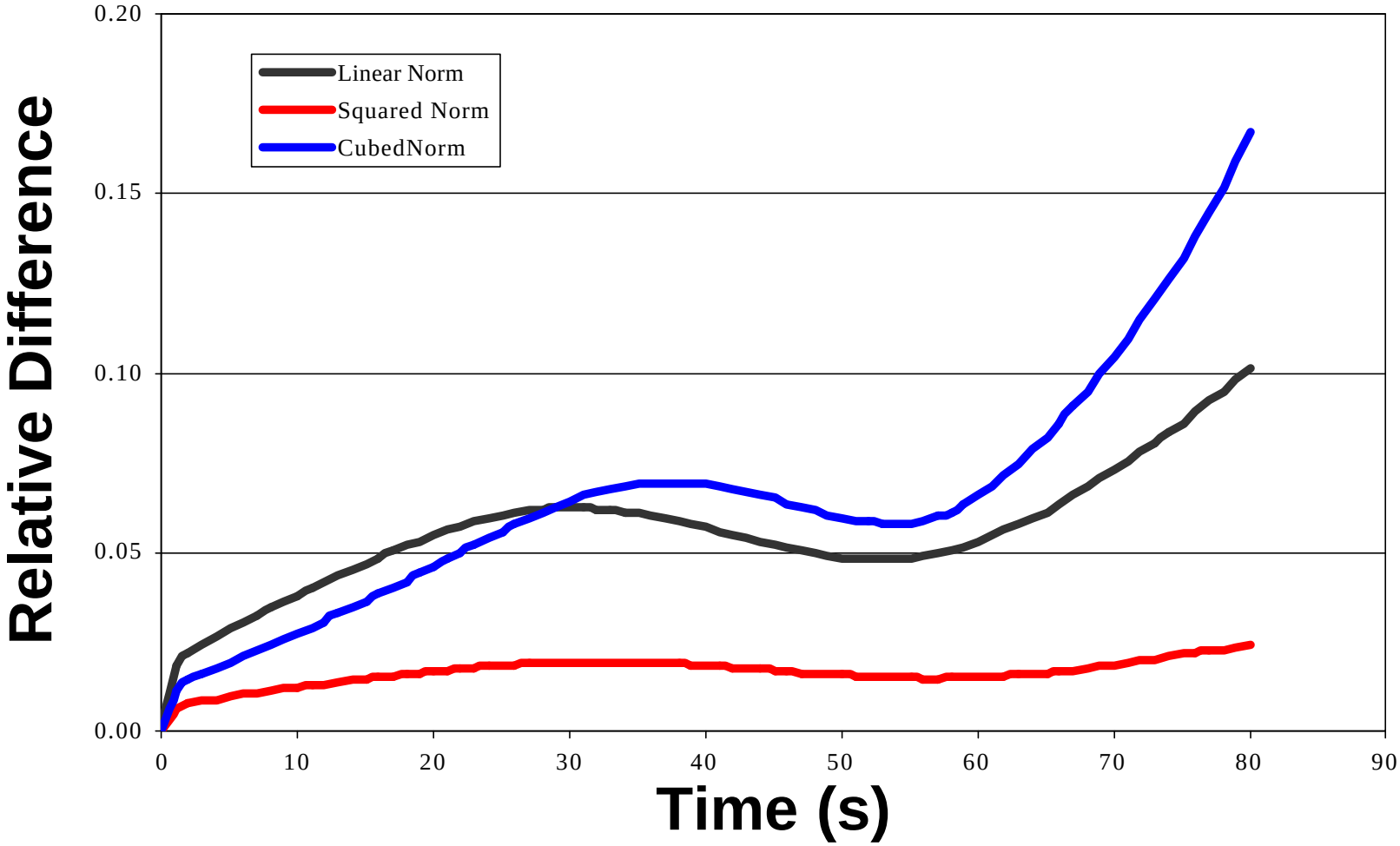
Chamber geometry (all physical aspects)

$$\frac{d}{dt} C_s = \frac{\alpha}{L} (C_s - C_g)$$

Using Sensor History to Predict Future Conditions



Reliability of the Predictions



Enabling Technology – BACnet

- What is BACnet?
- Benefits of a standard protocol
- What is the scope of BACnet?
- NIST BACnet Interoperability Testing Consortium
- ASHRAE formed SPC 135P (1987)
- 2,000 - 2,500 installed systems in 14 countries

BACnet Applications

- HVAC controls
- Lighting controls
- Security (access control)
- Fire detection/suppression systems
- Smart elevators
- Fault detection and diagnostic systems

Full Scale Demonstrations

- **Important part of the project is "buy-in" from the fire service – does it work in the real world**
  - Do through full scale demonstrations, press briefings, fire service involvement
- **First will be in New Castle County, Delaware**
  - County executive, two fire companies, press
  - Congressional Fire Service – possible staff involvement
  - Promote Fire Service grants for equipment
  - Reverse role – EMT to provider
- **Next at NIST, then ?**

County Municipal Office Building
New Castle, Delaware

This is the Difficulty

Systems in Place

A Working Example

Gather sensor data from buildings

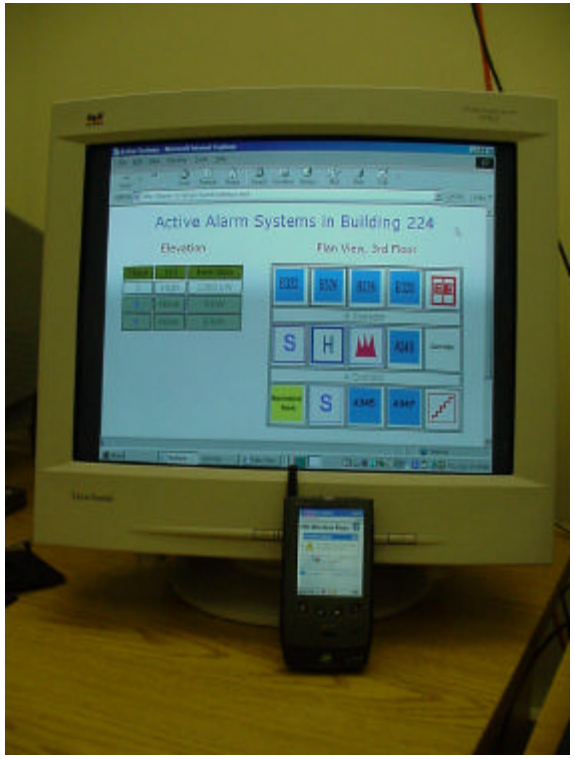
- Simplex (Tyco) – NIST buildings
- Edwards (SPX) – laboratory

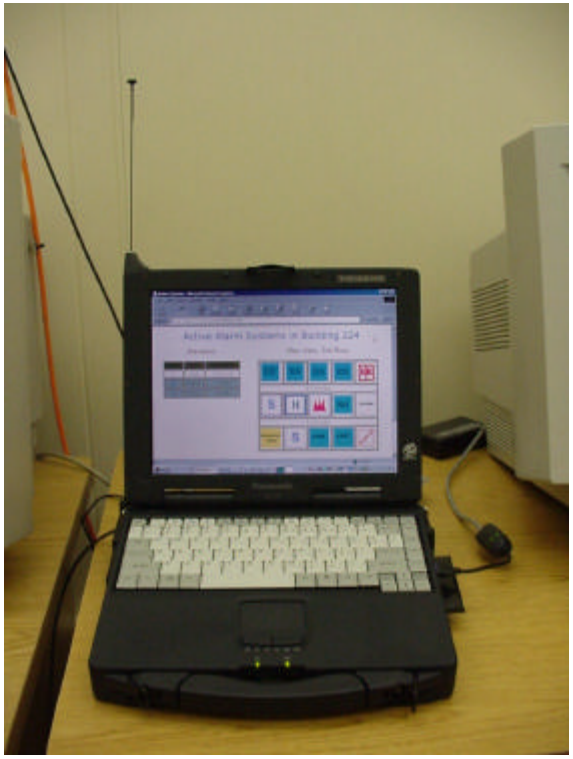
Generate html pages (familiar), use http, J and JS

Delivery of information (accessible where needed)

- Wired lines, Wireless

Array of Display Technologies





The Layout in Building 224

Outside	Corridor	Experiment

Active Systems - Netscape 8/23/2000 - 03:32 PM

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

Bookmarks Location: file:///I|/panel/active3.html02f3.html What's Related

Active Systems

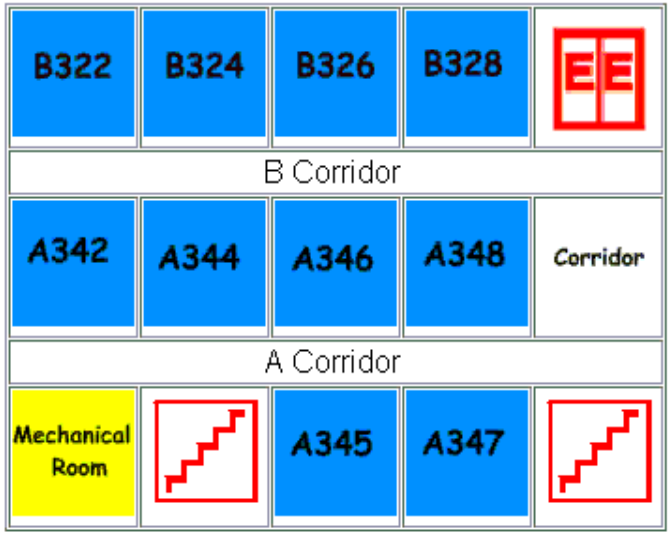
Special Equipment

Camera in A 346

Building 224 Elevation

Floor	Fire Size
3	NA
2	NA
1	NA

Building 224, 3rd Floor



Active Systems	Available Systems	Elevator Status	Voice Communication	Building Security	Staging Areas

Current time : 3:32 PM

Document: Done

Status of the Project

Status of the NIST/NEMA Consortium Project

- NFPA 72
- Example of information delivery

Recent Presentations

- Suppression and Detection Conference, Orlando, February, 2001
- AUBE, March, 2001

The next step

- Full scale rollout in New Castle, Delaware
  - Honeywell panel, Ademco monitoring

Why is this high reliability?

- **Information gathering is redundant**
- **Information can be shared by many**
  Wired, Wireless, Standard protocols
- **Validated algorithm for high likely-hood**
- **Metric for assured signal**
- **Actual threat**
  Insult to people or structure (T, CO, …)
- **Confirmation thru data fusion**
  From a single sensor to 10 000 sensors (NIST)

Why is this important?

High reliability implies all *relevant* information is available when needed

- Information gathering is redundant
- More information → Better decisions

Common display format

- Wider use → safer buildings
- Information can be shared by many → Wired, Wireless

Metric for reliability

- Validated algorithm for high likely-hood
- “If you cannot measure it, you don’t understand it” (Lord Kelvin)

Actual threat

- Insult to people or structure (T, CO, …)

Who Benefits

Fire Service

Faster response

More efficient deployment

Fire Protection Engineering

Building management for fire safety

NIST

Metric for time series

Fire Safety Systems Manufacturers

Customer driven requirements

Conclusions

- It is important to improve information delivery systems as building protection moves from passive to active
- A standard interface will drive user demand
- Standard systems allow interconnect and thus a great deal of end-user appeal
- We are progressing as per our plan, moving into full scale